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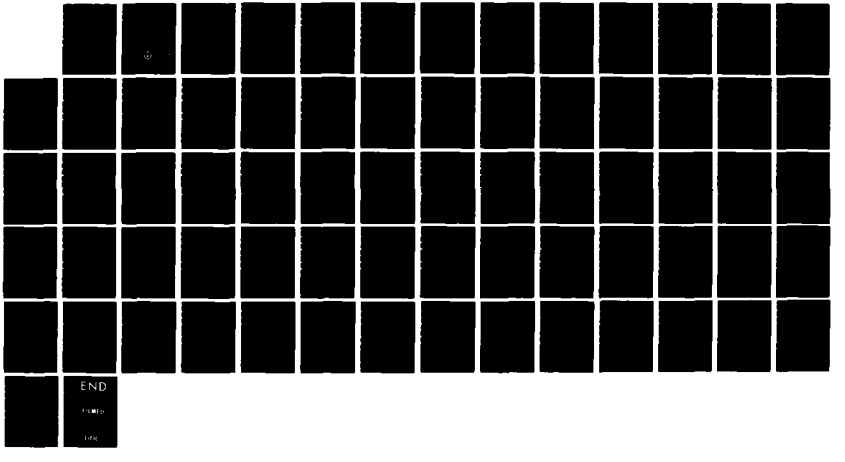

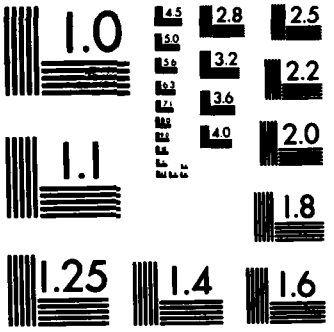

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REPORT OF THE DOD-UNIVERSITY FORUM

3

Calendar Year 1984

Co-Chairmen

Dr. Richard D. DeLauer
Under Secretary of Defense for Research and Engineering

and

Dr. Donald Kennedy
President, Stanford University

Co-Sponsors

Association of American Universities
National Association of State Universities and Land Grant Colleges
American Council on Education
Department of Defense

December 1984

Office of the Under Secretary of Defense for Research and Engineering
Washington, D.C. 20301

REPORT OF THE

DOD-UNIVERSITY FORUM

CALENDAR YEAR 1984

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UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

AND

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PRESIDENT, STANFORD UNIVERSITY

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IONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND GRANT COLLEGES
AMERICAN COUNCIL ON EDUCATION
DEPARTMENT OF DEFENSE

CALENDAR YEAR 1984 REPORT OF THE DOD-UNIVERSITY FORUM

CHARTERED: DECEMBER 15, 1983

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INTRODUCTION

In response to a request by the Committee on Armed Services of the U.S. House of Representatives, Under Secretary of Defense for Research and Engineering Richard D. DeLauer, constituted a Task Force of the Defense Science Board in 1981 to investigate the responsiveness of U.S. universities to national security requirements.

Their "Report of the Defense Science Board Task Force on University Responsiveness to National Security Requirements" which was completed in January 1982, highlighted numerous problems hampering both research and teaching in the nation's universities, and affecting their ability to contribute to national defense needs. Key among their findings was the need to restore a "healthier and more vital relationship between DoD and the university community."

As a result of their findings, the DSB Task Force recommended the creation of a "forum to allow periodic consultations between senior university representatives and DoD officials on the full range of research-related needs and issues that affect the Department's ties with universities." Following the publication of this report, further exploratory discussions conducted between DoD and the university community on the issues raised by the DSB's study, resulted in the decision in the summer of 1983 to begin the process leading to the establishment of the DoD-University Forum as a Department of Defense advisory committee.

As chartered on December 15, 1983, the DoD-University Forum is composed almost equally of university representatives and DoD officials with responsibility for university-related concerns. Designed to continue the dialogue generated by the DSB's recommendation, the Forum in its first full year of operation has demonstrated its value in enabling the DoD and the universities to address together, in candid and constructive discussions, the range of mutual concerns and opportunities that will shape future research and education programs of importance to the national defense.

Observers of university-government interactions have noted that the evolution of the Forum, along with the way it operates, is unique in the Federal sector. Care has been taken to charter and operate the Forum as a collaborative body, reflective of the mutual need to strengthen the relationships between DoD and the university community. The

DoD-University Forum is jointly sponsored by DoD and three higher education associations: the Association of American Universities, the National Association of State Universities and Land Grant Colleges and the American Council on Education. Forum members are drawn equally from DoD and the university community, with university members and associate members nominated by the association co-sponsors and approved by the Secretary of Defense. The Forum and its Working Groups are co-chaired by a university representative and a DoD official, and meet at the invitation of both co-chairs. Meetings are alternately hosted by the higher education associations and DoD, while administrative and staff support to the Forum is jointly shared by DoD and the Association of American Universities.

Rather than being awkward, this arrangement has worked well, has enhanced the operation of the Forum, and contributed to the cooperative spirit which has underpinned deliberations between DoD and the academic community on many difficult issues.

Among the issues dealt with over the past year have been the development of export control policies which affect university fundamental research and publication; engineering and science education; and foreign languages and area studies.

In particular, the DoD-University Forum and the discussions which led to its establishment as a formal advisory committee to the Department of Defense, have helped to bring a new awareness to the defense community of the vital role which the nation's university research and education programs play in maintaining the country's economic and military strength.

This report of the first full year of operation of the DoD-University Forum begins with an overview of the consequences of our declining investment in research and education, and the Forum's recommendations for actions to be taken to restore the United States scientific and technological leadership position.

Part II of the report describes the initiative undertaken by Under Secretary of Defense Richard D. DeLauer to bring this issue to national attention and the response he received from industry, academia and the technical and discipline societies.

Parts III, IV and V, describe the accomplishments of the Forum Working Groups on Export Control, Engineering and Science Education and Foreign Languages and Area Studies, respectively.

Appendices include the Charter of the DoD-University Forum; and Forum and Working Group membership lists as of October, 1984.

PART I

RESTORING THE UNITED STATES' SCIENTIFIC AND TECHNOLOGICAL LEADERSHIP POSITION IN THE WORLD: A NATIONAL PRIORITY

The DoD-University Forum has given considerable thought to the consequences of the Nation's declining investment in R&D, the resulting deteriorating conditions in science and engineering education, and the actions which need to be taken to restore the United States' scientific and technological leadership position in the world. The Forum members present this summary of the current situation, along with recommendations for solving the problems identified.

DECLINING U.S. INVESTMENT IN U.S. R&D:

Since World War II we have relied principally on the nation's universities to conduct the scientific research which has underpinned the technological innovations on which our economy and national defense are based. This relationship between universities and government, while strong throughout the post-WWII years, was given increased impetus following the launching of Sputnik in 1957, bringing again to the nation's attention the need for a strong scientific and technical research and education base for the country.

During the 1970's, however, this relationship between government and the nation's research universities began to deteriorate, with a corresponding decline in government support for research and education. During that same period, many corporations also reduced their basic research efforts, relying on the universities and government laboratories to provide them with basic research results without a commensurate investment.

The Mansfield Amendment to the FY 1970 DoD Authorization Act further exacerbated DoD's deteriorating relationship with the nation's research universities, and restricted the types of research projects DoD could fund.

In its FY 1970 version, the Mansfield Amendment directed that none of the funds authorized to be

appropriated to DoD could be used to finance any research project or study unless it had a "direct and apparent relationship to a military function or operation."

In the FY 1971 DoD Authorization Act, the Amendment language was softened, but made a permanent part of the law under which DoD operates. The amended Act directs that DoD fund only research projects or studies which "in the opinion of the Secretary of Defense" have "a potential relationship to a military function." While the intent of the amendment is to insure that defense dollars are spent in support of the defense mission, research generates its own agenda and often creates undreamed-of opportunities.

The best basic research explores the very limits of scientific knowledge, and not even the most prescient scientist can foresee the ultimate applications which may result from the explorations on the frontiers of knowledge. Yet, the history of defense technology is replete with examples of crucial weaponry arising from fundamental research in areas that, "a priori," appear to have no connection with defense.

Who, except in hindsight, would have dreamed that research in the esoteric field of solid state physics would lead to the development of the transistor, and eventually to the microcomputers that are crucial to this nation's high technology weapons? Or, that chemical physics research on gaseous diffusion would lead to the methodology that made possible the effective separation of isotopes of uranium, and therefore, the atomic bomb?

Throughout the period of the 1970's, the nation failed to recognize that its investment in research and education, particularly in our universities, was falling to inadequate levels. On the other hand, as U.S. investment in civilian (non-military) research and development declined in real terms, France, West Germany, Japan and the United Kingdom increased their R&D expenditures substantially. While the U.S. investment in R&D had declined to only 1.6 percent of its GNP by 1978, West Germany had increased its investment in R&D to 2.1 percent of its GNP, and Japan to almost 2 percent.

THE CONSEQUENCES OF OUR DECLINING R&D INVESTMENT:

The erosion which we have allowed to occur in our investment in research and education has had far-reaching consequences, dulling our competitive edge and endangering the technological advantage on which the national defense is based.

As Niels Reimers, Director of the Office of Technology Licensing at Stanford University points out in his article, "The Government-Industry-University Interface: Improving the Innovative Process":

> Productivity has been dropping in the U.S. since 1978, and our share of the world's market declined by 23 percent in the 1970's. In high-technology goods, the United States' share of the world market declined from 30 percent in the 1960's to about 20 percent by 1982. Selected industries in high technology showed even sharper percentage drops: telecommunications fell from 30 percent to 15 percent, and pharmaceutical drugs decreased from 28 percent to 15 percent.

Today, it is an accepted fact that the quality of what we produce in America is in jeopardy. Robert Frosch, Vice President of General Motors Corporation, writing on "Improving American Innovation: The Role of Industry in Innovation," says:

> Apparently our nearly effortless ability to provide this continuing flow of innovative products and to maintain our reputation for them, and thus our sales, seems to have declined, perhaps almost to have vanished in some key areas. We perceive our reputation and competitive edge to have slipped badly and to continue to slip in world markets. Worse, foreign competition has invaded a number of U.S. market sectors, e.g., automobiles, consumer electronics, and a variety of household appliance lines and industrial goods with products that are perceived to be, and frequently are, technologically more advanced and of higher quality than our domestic production. Even in fields in which Americans are the original inventors and developers, we are overtaken within a short time by foreign versions of our original ideas. We no longer necessarily dominate markets, even with our own inventions.

Steven Muller, President of Johns Hopkins University, pinpoints the cause of this decline in the quality of what we produce and hence the consequences noted above. He says in his essay, "Research Universities and Industrial Innovation in America":

> As for private industry, corporations dependent on science and technology have an unavoidable stake in the adequacy of instrumentation and the quality of research in the major research universities. The essential linkage between the universities and industrial innovation and vitality consists of people-related as opposed to product-related research. The article of faith within the university community which insists on the inseparability of research and teaching is not merely sacrosanct -- it is practical wisdom as well. ...Both government and industry are inescapably dependent on a flow of talent which the universities produce. To a large degree, the quality of government and industry in the age of technology is determined by the quality of available talent....

Our decreasing investment in research and education over the past decade, however, has severely affected the ability of universities to produce the quality of scientific and technical talent required to maintain our competitive edge. Among the consequences of our diminished support for research and education are: increasingly obsolete university research laboratories and equipment; a serious shortage of faculty qualified to teach state-of-the-art technology; large declines in the numbers of American citizens pursuing graduate degrees; and poorly prepared high school graduates.

(1) INCREASINGLY OBSOLETE RESEARCH LABORATORIES AND EQUIPMENT: Recent studies have shown the need for $1 billion to $2 billion worth of equipment to replace obsolete research instrumentation in the nation's universities. In addition, laboratory facilities, themselves, are now outdated and need to be replaced or modernized.

- Research equipment and facility needs are a particular problem if our nation's universities are to stay on the forefront of state-of-the-art research. The nature of modern instrumentation and the sophistication of the analysis required to use information from such measurements, are such that a very great advantage accrues now to the well-equipped national laboratories or only a few university laboratories.

- During the past decade, computer-aided design and computer-assisted manufacturing methods have provided important gains in productivity for some large companies in this country. The apparatus required to teach these methods to students, however, is generally unavailable in engineering schools. Consequently, a good deal of instruction being offered may in fact be obsolete, requiring large investment by employers for on-the-job training for new graduates.

The consequences of this situation are diminished research productivity and competitiveness and compromised quality of graduate education programs in equipment-dependent fields.

(2) A SERIOUS SHORTAGE OF FACULTY QUALIFIED TO TEACH STATE-OF-THE-ART TECHNOLOGY: There is a shortage of approximately 1800 qualified engineering faculty members, while shortages in the computer professions have also been reported. It is believed by some that the reported shortage of faculty is actually understated: adjusting the student-to-teacher ratio to 1968 levels would require 5,000 new faculty in addition to the currently identified shortage of 1800 instructors.

Faculty teaching loads have consequently increased because enrollments have far exceeded the capacity of the faculty to absorb them; further the increased instructional load makes it difficult for faculty to engage in scholarly activities and remain on the frontier of technology.

(3) LARGE DECLINES IN THE NUMBERS OF AMERICAN STUDENTS PURSUING GRADUATE DEGREES: The number of engineering doctoral degrees awarded to U.S. citizens declined by 42 percent between 1968 and 1982, while the number of advanced degrees awarded to foreign nationals almost tripled during this same period. Nearly half of the engineering Ph.D.'s awarded now go to foreign nationals.

The decline in the numbers of American citizens pursuing advanced degrees can be attributed to several factors. First, marketplace demand for engineers is such that attractive job offers, providing immediate return on a student's investment in education, are luring bachelor degree recipients into industry. In the past, many of these students would have gone to graduate school.

In addition, there is far less financial support available to graduate students today than was available in the past: by 1983, the Federal Government was supporting

fewer than 10,000 fellowships -- 40,000 less than in 1968 -- and only 1,600 were in engineering and science. Finally, as students observe faculty members experiencing heavy teaching loads and reduced ability to conduct research, they are developing negative attitudes toward graduate study and careers in research and teaching.

(4) POORLY PREPARED HIGH SCHOOL GRADUATES: Problems similar to those facing the nation's universities have been identified at the high school level as well: a severe shortage of teachers qualified in mathematics and science (Georgia and several other states are reportedly exploring the possibility of importing math and science teachers from Germany); inadequate laboratory equipment and facilities to teach rudimentary chemistry, physics and biology; and a decline in opportunities for teacher in-service training and continuing education to stay abreast in their fields. These problems are not only affecting the preparation of college-bound students who wish to pursue undergraduate degrees in scientific and technical fields, but are also contributing in general to a technologically illiterate populace unable to participate effectively in an increasingly technological society.

The ramifications of this situation can have long-term debilitating effects on the nation's economic health and defense posture. A recent National Science Foundation study undertaken to identify potential labor market imbalances through 1987 evaluated four scenarios representing combinations of low and high macroeconomic activity (1.6 percent and 4.3 percent growth per year respectively), and low and high growth rates in real defense expenditures (3.1 percent and 8.1 percent respectively). Based on these scenarios, growth in employment for each of the major occupational categories -- engineers, scientists, and technicians -- is projected to range from 2.5 percent to 4.0 percent per year.

Shortages (representing at least a 10 percent shortfall in supply) are projected for aeronautical/astronautical engineers and computer specialists. By 1987, the shortfall for the former will vary from 15 percent to 45 percent, representing approximately 10,000 to 35,000 personnel; for the latter, the comparable range will be 15 percent to 30 percent, or about 115,000 to 140,000 personnel. At high projected levels of Defense spending, the shortfall of electrical/electronic engineers is estimated to be almost 10 percent of supply, or roughly 30,000 personnel. While job opportunities can be expected to draw engineers into fields where shortages are projected, this shift assumes that engineering schools can further expand their enrollments.

In fact, engineering schools are already at saturation in these fields, and many are now limiting their enrollments.

THE RECOMMENDATION OF THE DOD-UNIVERSITY FORUM:

This Administration has recognized that the nation's economic health and security are dependent upon solving the problems identified. Initiatives are currently underway to strengthen education at all levels; to improve university research instrumentation; to identify research facility needs; and to support young faculty members to alleviate the faculty shortage. Private sector partnerships between academia and industry are also emerging in greater numbers to strengthen industry-university interactions.

These initiatives are encouraging and hold promise for the future; but care must be exercised lest we expect that these activities are quick-term solutions to the multiple, long-term problems which we must address.

To regain the United States' technological leadership position in the world, a renewed and sustained national commitment to long-term investment in research and education -- led by the President and based on collaborative partnerships among industry, education and government --must continue to be an essential ingredient of domestic policy.

The Federal Government must assume a leadership role (1) by increasing its own investment in scientific and technological research and education; (2) by creating incentives for industry to enlarge its contributions to research and education; and (3) by encouraging the development of new types of partnerships between local industry and educational institutions designed to strengthen the quality of research and teaching at all levels.

The Forum commends the efforts which DoD has made over the past four years to increase its own investment in research and support for science and engineering education, and recommends that these initiatives continue to remain a top priority for the Department in the future. The Forum further recommends that DoD continue to exert its leadership within the Federal sector, and nationally, to generate an awareness of the problems and to demonstrate model approaches for solving them.

ACKNOWLEDGEMENTS:

Quotations from Neils Reimers, Robert Frosch and Steven Muller, cited in this part were excerpted from articles published in Technological Innovation in the 80's, edited by Dr. James S. Coles, The American Assembly, Columbia University, New York, N.Y., 1984.

PART II

EXPRESSIONS OF SUPPORT FOR THE USDRE'S NATIONAL INITIATIVE

Stimulated in part by the report of the Engineering and Science Education Working Group of the DoD-University Forum and acting in his role as Under Secretary of Defense for Research and Engineering, Dr. Richard DeLauer wrote to the President in late March, 1984 to request that a national initiative be launched to restore the United States' leadership position in science and technology.

To assess support for such an initiative, Dr. DeLauer then wrote to several hundred university presidents, CEO's of the nation's major corporations and the heads of the technical and discipline societies.

The following is his letter of April 16, 1984 to these individuals:

"I would like to share with you some excerpts from a letter which I recently sent to the President calling for a Presidential initiative to restore the United States' scientific and technological leadership position in the world.

"I have been giving considerable thought for many years -- in industry, on university boards and in government -- to the deteriorating conditions in scientific and technological research and education which are affecting both our competitive stance in the world, as well as our national security. In recent months my concerns about this issue have been further reinforced by the DoD-University Forum and the recent Forum Working Group Report on Engineering and Science Education. I believe that we must begin now to reverse this decline.

"With Secretary Weinberger's encouragement, I wrote the following to the President:

> **In 1957 when the Soviet Union launched Sputnik, the Eisenhower Administration initiated an intensive campaign to regain our world leadership position in science and technology. For about a decade following that event, the United States built a scientific and technological base second to none by supporting quality education and research in the sciences and engineering which paved the way for today's advances in medicine, agriculture, energy, electronics, and aerospace -- advances undreamed of in 1957. A key ingredient in those years was a vision of what could**

be achieved by educators, industry and government working together to strengthen science and engineering research and education at all levels.

Since the mid-70's however, we have allowed our technological lead to erode and our support for education and research to decline. Our research and teaching institutions already are having serious difficulties producing the quality scientists and engineers needed to regain the technological lead so essential to our future security and economic well being.

Recent studies now show that as the economy improves and production increases, the United States will experience serious shortages of certain types of scientists, engineers and other trained support personnel in fields vital to both the nation's economic health and its defense. Shortfalls in some specialty areas are already slowing our recovery, and will affect such pioneering efforts as DoD's strategic defense initiative and NASA's space station, as well as our continuing advances in fields such as microelectronics and biotechnology.

Education at all levels is at present unprepared to meet this challenge: the deteriorated state of high school education in science and mathematics has recently been well-documented, while similar studies of higher education have revealed major deficiencies in engineering faculty, obsolete laboratory facilities and equipment, and large declines in the numbers of American citizens pursuing advanced degrees. We can no longer rely on our educational institutions alone to provide the levels of science and engineering education required to maintain leadership in an increasingly technological world. A renewal of our traditional collaboration among schools, universities and high technology workplaces is essential if we are to recover lost ground and maintain our technological edge.

"I would very much appreciate your support in generating the climate we need for increased investment in research and education on which future technological advances depend, and would encourage you to discuss this idea with your colleagues to help us gain the national attention which I feel this initiative deserves."

Throughout the spring and summer of 1984, Dr. DeLauer received hundreds of overwhelmingly positive responses to his letter. He found that he was not alone in his concern for the consequences of allowing the nation's technological lead to erode. It became evident that broad-based support exists within both the private and public sectors for a national intiative designed to create a climate for increased investment in research and engineering.

The following are excerpts taken from only a few of the letters which he received in response to his initiative:

"The need is clear, both to meet national security objectives and to enhance the ability of the nation to improve its industrial position in an increasingly competitive world."

Lawrence J. Korb
Assistant Secretary of
Defense (Manpower,
Installations and
Logistics)

"I share your view and assure you of my assistance in any appropriate way as you continue to encourage the President to take the initiative on this important subject...."

William J. Casey
Director of Central
Intelligence

"This is an excellent statement and you can count on me to do my best to support this initiative. One of our problems is to convince our various constituencies about the urgency of your message...."

Dale R. Corson
Chairman
Research Roundtable
National Academy of
Sciences

"The point you make that we have not been able to maintain the kinds of facilities, equipment and support that can guarantee the effective translation of faculty expertise and creativity will be echoed in my testimony before the House Committee on Science and Technology.... In it I will be urging that all government agencies that draw from the research universities be empowered to undertake a conscious rebuilding of the infrastructures of those institutions."

Frank H. T. Rhodes
President
Cornell University

"I share completely your views on the decline of research (and) technical education in the U.S. -- especially at the high school level....I hope the President does something positive in response to your letter."

William A. Anders
Executive Vice President
Aerospace Textron, Inc.

"...I think that you have described both the problem and the solution in a very articulate way. Moreover, I feel that you may count on strong support among my colleagues at Raytheon, as well as the educational, scientific and industrial leadership within my acquaintance."

Thomas L. Phillips
Chairman of the Board
Raytheon Company

"I certainly share the convictions you expressed and perhaps with an even greater sense of urgency than that conveyed in your letter. We are facing a situation in our country which can be called nothing less than a crisis..."

Robert MacVicar
President
Oregon State University

"As you know, the National Academy of Engineering shares the concerns expressed in your letter to the President and is actively moving in a number of directions to encourage the kind of climate needed for investment in research and education."

Robert M. White
President
National Academy of
Engineering

"I will do my best to communicate your point of view and to support in discussions with others both in Congress and nationally with whom I interact, how critical it is that we increase our investment in research and education for the needs of our scientific and technological endeavors."

C. Peter Magrath
President
University of Minnesota

"Of course I agree completely with your statement of the problem and with your sense of urgency regarding the need to take action to improve the situation.... You can be sure that I will do anything I can to help you in promoting increased national attention to the situation."

Allen E. Puckett
Chairman of the Board and
Chief Executive Officer
Hughes Aircraft Company

"If we are to be successful in this enterprise, it is imperative that the tools of scientific research -- our facilities, equipment, and instrumentation -- be substantially improved. As you noted, our educational institutions cannot proceed alone in such a venture. Renewed collaboration among education, industry, and government is essential if this initiative is to prove fruitful.... We at the University of Pennsylvania appreciate your efforts, and stand ready to join in this initiative."

Sheldon Hackney
President
University of Pennsylvania

"We at the University of California at Berkeley fully support the thrust of your letter and will endeavor to increase our efforts in generating support for a broader understanding of the problem and in identifying possible solutions...."

Ira Michael Heyman
Chancellor
University of California,
Berkeley

"I could not agree more. Creating that climate - raising the level of awareness about our national jeopardy - should be a priority and should receive the exposure that the White House can give it. This gives us an opportunity to reinforce the issue in the private sector. United Technologies would welcome that initiative from Washington, and would cooperate fully to bring this issue before the public."

Harry J. Gray
Chairman and Chief
Executive Officer
United Technologies

"Surely government, education, and industry must continue to explore new ways of cooperating to ensure that the next generation of scientists and engineers will continue the tradition of excellence that has characterized American science and engineering in the past. We are grateful that you are carrying this message to the President and to your colleagues in government and industry."

Jerome B. Komisar
Provost
State University of
New York

"The American Society for Quality Control supports the ideas expressed in your letter."

Sandra J. Edson
Executive Director
American Society for
Quality Control

"I could not agree more with your assessment.... Certainly you have the support of General Motors and technically-based industry in this regard. GM continues to be one of the leaders in educational giving among major firms in the nation. In 1982, GM's total educational contributions were $22.3 million, most of which is science and engineering oriented. We plan to continue this substantial commitment...."

Roger B. Smith
Chairman
General Motors Corporation

"I was delighted with your letter.... ...I have been very active around the country over the past year and a half trying to generate bipartisan support for investment in research and education at all levels.... I believe that priority must go to a broad program of grants for U.S. students undertaking doctoral studies in science and engineering and for a major effort to vastly improve...equipment available to support...graduate level education.... I do not believe our educational institutions will be able to accomplish the necessary level of support on their own, and leadership from the Federal Government will be mandatory.... What we really need is leadership from the President."

B. R. Inman
President and Chief
Executive Officer
Microelectronics and
Computer Technology
Corporation

"What you have told the President...and what you have urged on him as policy are wholly congruent with the goals of the universities that make up this organization. We are prepared to work with those whom the President might designate to move in the direction you have charted."

Robert M. Rosenzweig
President
Association of American
Universities

"The issues that you raised are of critical importance to the future of this nation and ones which have been far too long neglected.... The mathematics and science education that we provide to our high school students is neither adequate to attract young people into these areas nor to prepare them for such careers, and at the same time our colleges and universities are at very substantial risk both financially and philosophically, in my view...."

D. Allan Bromley
Henry Ford II Professor and
Director
A. W. Wright Nuclear
Structure Laboratory
Yale University

"I'm in complete agreement with your sentiments. We here at GA are endeavoring to increase our interaction with the academic community and other scientific and engineering institutions. ...If you have any specific ideas as to how we at GA can help...please let us know."

Harold M. Agnew
President
GA Technologies, Inc.

"I am encouraged by your letter because it is important for federal leaders to appreciate as you do, the essential role of universities in providing national preeminence in science and technology.... We are now redoubling our efforts to establish collaborative relations with industry.... These are appropriate steps toward an improved climate for the research and education needed for future technological advances.

John S. Toll
President
University of Maryland

"I heartily concur with the sentiments and the recommendations which are included in your letter to President Reagan, which far transcend concerns about our defense posture only.... We have made increased contributions to universities, we have initiated joint R&D programs...we have contributed equipment, we have encouraged our people to serve as adjunct and visiting professors.... But I would have to admit that these efforts fall short of meeting the challenge which our nation faces. You are correct in implying that the threat to our technological lead is even greater than it was in 1957...."

Warde F. Wheaton
Executive Vice President
Aerospace and Defense
Honeywell, Inc.

"I too share your concern that strong national leadership must be directed toward the upgrading of our training and research facilities in the fields of science and technology.... Without additional support, we face the risk of seeing the significant -- and predominately federally-supported -- investments of the past wasted. This can only have dire effects on the continued vitality of research and the ability of this nation's universities to attract the best people to science and engineering professions."

A. Bartlett Giamatti
President
Yale University

"Renewed emphasis on science and engineering education, to insure that we 'maintain leadership in an increasingly technological world,' is of vital importance to our national well-being. Emphasis and indeed 'renewal' of linkages among elementary and secondary education, our universities, and industry remain essential."

John W. Ryan
President
Indiana University

"...We would welcome a Presidential initiative to enhance and sustain excellence in science, engineering, technology and education. We view each of these as long-term investments and are consequently apprehensive about approaches that might result in short-term fixes followed by lasting disabilities.... The longer-term strength of science, engineering and technology is as dependent upon the decisions made by an informed public as it is upon exceptional technical capabilities of our work force and upon exceptional leadership potential of our scientists and engineers...."

Anna J. Harrison
President
American Association for
the Advancement of Science

"...The extraordinary accomplishments in engineering and science in the 60's occurred at least partially as a result of a vision or a plan born in Washington and strongly promoted by the White House.... In Wisconsin, the support for engineering education within the two doctoral granting universities is terribly inadequate and has been that way for some time. ...Both are suffering unreasonably because of many years of grossly inadequate resources. ...We are now forced to try to play catch-up throughout the United States as well as Wisconsin.... My only criticism is that these efforts are long overdue."

Charles F. James, Jr.
Dean of the College of
Engineering and Applied
Science
University of Wisconsin-
Milwaukee

"Your proposal for a Presidential initiative to renew our traditional collaboration among schools, universities, and industry should have the support of all those concerned with our national security and our competitive posture in the world.... We fully support your call for increased investment in research and education, and are prepared to discuss specific initiatives...at any time you desire."

Roy A. Anderson
Chairman of the Board
Lockheed Corporation

"...We need a renewal of a federal capital development program to permit the best universities to build adequate research and teaching facilities; a reduction in the hassles associated with acquiring and utilizing research funding; an increase in the number and quality of stipends available to graduate students for the pursuit of careers in science and engineering. We do not need, in my opinion, still more studies.... I fear that we are moving toward a society in which a small minority are technologically skilled and sophisticated, while the great majority of people are so ill-informed on the role of science and technology, and the nature of scientific and technological progress, that they are incapable of appreciating the long-term implications of fiscal and social policies that could determine the fate of the universities...."

Theodore L. Brown
Vice Chancellor for
Research and Dean
The Graduate College
University of Illinois at
Urbana-Champaign

"We are aggressively pursuing joint research projects with private industry, recognizing that such efforts are mutually beneficial and have positive results for the nation as a whole.... I share your confidence that universities, industry and government working together can meet the challenges of the latter part of this century and beyond but commitment and leadership at all levels will be needed...."

Gene A. Budig
Chancellor
University of Kansas

"The NAM shares your concern with regard to the deteriorating conditions in scientific and technological research and education..."

Alexander B. Trowbridge
President
National Association of
Manufacturers

"Please be assured that EIA will support your proposed Presidential Initiative to Restore U.S. Scientific and Technological Leadership.... Your objectives and ours are entirely compatible."

Peter F. McCloskey
President
Electronic Industries
Association

"I second the sentiments which you have expressed in your letter to the President...."

Harold T. Shapiro
President
University of Michigan

"We support the conclusions stated in your letter, that a renewal of the traditional collaboration among schools, universities and high-technology workplaces is essential.... Please be assured of our desire to support the objectives set forth in your letter in concrete terms."

S. Russell Stearns
President
American Society of Civil
Engineers

"I was...pleased to know of your letter to President Reagan.... As past Chairman of the Business-Higher Education Forum and now a member of the Presidential Commission for Industrial Competitiveness, I have continuously encouraged and supported top level leadership initiatives that would enhance and restore our country's pre-eminence in science and technology...."

R. Anderson
Chairman of the Board and
Chief Executive Officer
Rockwell International
Corporation

"I want you to know that I support your assessment wholeheartedly."

Wilbert Greenfield
President
Virginia State University

"I certainly agree with your comments and thoughts which were well expressed in your letter to the President.... The economic well-being of the United States and the future of high technology companies such as Sperry are vitally dependent on the output of our educational institutions."

G. G. Probst
Chairman and Chief
Executive Officer
Sperry Corporation

"Our competitive position as a nation depends on a sustained and substantial collaborative investment on the part of universities, industry and government in quality research (including importantly basic research), in graduate training, and in the state-of-the-art equipment and facilities that are essential to pioneering inquiry. I hope that your letter and your personal commitment can help to promote the actions necessary both to tap and to replenish the scientific and technological potential of our colleges and universities."

William G. Bowen
President
Princeton University

"Please be assured that I believe strongly in quality education and research in the sciences and engineering and that I have supported many efforts to strengthen these areas. I am pleased to join you in your call for greater cooperation between educators, industry and government as an essential ingredient in a national initiative to regain our technical leadership."

Thomas V. Jones
Chairman of the Board and
Chief Executive Officer
Northrop Corporation

"We strongly endorse this concept.... We applaud your leadership on this important issue."

Bryce Jordan
President
Pennsylvania State
University

"I was pleased to read of your letter to President Reagan.... Getting this country's scientific and technological resources back on track will require a great deal of leadership from all of us in the business community."

Mark Shepherd, Jr.
Chairman
Texas Instruments

"The individual and institutional members of ASEE have been heavily involved in a variety of efforts aimed at generating the climate which you suggest we must have for increased investment in research and education.... We shall be pleased to assist you in every way possible to insure that the initiative which you propose gains the national attention which it deserves."

W. Edward Lear
Executive Director
American Society for
Engineering Education

"We in higher education, of course, have had these concerns all along, and you may be assured or our support."

Edward J. Boling
President
University of Tennessee

"I understand the issues which are outlined in your letter to the President, and I agree with you that they are absolutely critical to the leadership of the United States in the world.... Not only do the universities conduct the critical advanced research and development for the Department of Defense, but more importantly they educate the graduate students who serve our whole country.... I can assure you that Harris Corporation is working the problem to the extent that it is feasible...."

Joseph A. Boyd
Chairman
Harris Corporation

"I, of course, agree with you completely. Heroic efforts will be required to bring manpower up to our demands. I do not know why we have to go through these cycles every ten to fifteen years or so. There must be a better system of coordination between government, industry and universities."

William A. Nierenberg
Director
Scripps Institution of Oceanography
University of California, San Diego

"IBM shares your conviction that technical knowledge and well-trained people are key ingredients of the technical capability on which industrial competitiveness and national security rest.... The government must bear primary responsibility for the support of fundamental research in science and engineering in our universities. We support expansion of these government efforts within the context of a first priority need to narrow the federal deficits."

John R. Opel
Chairman of the Board
IBM, Inc.

"I know that many of us feel as you do, and you certainly have my support and that of my colleagues at Raytheon. We will give some thought as to what we can do here to support your ideas on a national scale."

D. Brainerd Holmes
President
Raytheon Company

"I fully agree with your comments.... We firmly believe that an on-going national commitment to a healthy engineering education system is essential to maintain and extend U.S. competitiveness in the global marketplace...."

Donald G. Weinert, P.E.
Executive Director
National Society of
Professional Engineers

"Your letter...was an encouraging signal that a serious national problem has been recognized at the highest level.... I feel certain that the very responsive and responsible leaders of our defense industry will welcome effective government action to insure our scientific and engineering future in this competitive world. We, at ADPA, will work toward that end in any way that will be useful to you...."

Henry A. Miley, Jr.
General, USA (Retired)
President
American Defense
Preparedness Association

"...I very much agree with everything you stated in your letter. ...one of the key problems is the near impossibility of getting the right capitalization for the educational functions and research functions we have to perform. ...key components such as facilities are nearly impossible to get except through a rich donor and...there are difficulties because of the reluctance of people to contribute to bricks and mortar. ...I think your letter is very much on the mark and I encourage your efforts."

Daniel Berg
Acting President and
Provost
Rensselaer Polytechnic
Institute

"That is a super letter, and it deserves to be given wide-spread attention."

George A. Roberts
President
Teledyne, Inc.

PART III

REPORT OF THE DOD-UNIVERSITY FORUM WORKING GROUP ON TECHNOLOGY EXPORT CONTROLS

One of the principal concerns that caused the DoD-University Forum to come into being was that of the effect of export control on the freedom to publish the findings of scientific research. The Working Group on Technology Export Control, co-chaired by Dr. David Wilson of the University of California, and Dr. Edith Martin, Deputy Under Secretary of Defense for Research and Advanced Technology, was the first Working Group to meet, and has met frequently since the inception of the Forum. Its advice has been very helpful to DoD, and beyond DoD as well.

At the beginning of the calendar year the Working Group was still trying to implement the "Corson report" (a report of the National Academy of Sciences Panel on Scientific Communications and National Security, under the chairmanship of Dr. Dale Corson, published in September 1982). The Corson report had made major contributions by clarifying the issues, and had triggered a 1982 National Security Study Directive leading to two successive committees chaired by Office of Science and Technology Policy (OSTP), neither of which published a report before being dissolved.

The principal task before the Working Group at the start of 1984 was to find a definition and subsequent implementation of a category called "unclassified but sensitive," arising out of the "gray area" (meaning: neither classified or "black," nor unclssified without any retrictions, or "white"), which the Corson panel had agreed to recommend. The Working Group had little progress to report on this issue (of "sensitive" information), and so the Forum at its April 17, 1984 meeting re-directed the group to abandon this category, and to come up with some workable arrangement based only on the two existing and well established categories of "classified" and "unclassified."

Following the Forum meeting, Dr. Martin, during testimony on May 24, 1984, before a joint hearing of the Subcommittee on Science, Research and Technology and the Subcommittee on Investigations and Oversight, of the House Committee on Science and Technology announced a draft National Policy on the Transfer of Scientific and Technical Information. That draft had been agreed to a few days earlier between DoD and OSTP as a basis for a national policy.

With the charge given it by the Forum, the Working Group began to discuss alternatives starting with the draft national policy announced by Dr. Martin and subsequently revised slightly on June 15, 1984. The ideas discussed and agreed to at the Working Group meeting on September 14, 1984 were then articulated in a memorandum to the Assistant Secretaries of the Army, Navy and Air Force, and to the Directors of the Defense Advanced Research Projects Agency (DARPA) and the Defense Nuclear Agency (DNA). The memo, which is self-explanatory, was signed by Dr. DeLauer on October 1, 1984 and is reproduced on the next page. Immediately following the memo is an editorial by Dr. DeLauer, published in the October 5, 1984 edition of Science (Vol. 226, No. 4670, page 9), which contains many thoughts arising out of Forum discussions of this issue. While neither the memorandum of October 1, 1984 nor the editorial of October 5, 1984 are likely to be the "last word," it is hoped that they will usher in a new era of even closer cooperation between the DoD and the university community.

THE UNDER SECRETARY OF DEFENSE

WASHINGTON D C 20301

RESEARCH AND
ENGINEERING

01 OCT 1984

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT AND ACQUISITION)
ASSISTANT SECRETARY OF THE NAVY (RESEARCH, ENGINEERING AND SYSTEMS)
ASSISTANT SECRETARY OF THE AIR FORCE (RESEARCH, DEVELOPMENT AND LOGISTICS)
DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
DIRECTOR, DEFENSE NUCLEAR AGENCY

SUBJECT: Publication of the Results of DoD Sponsored Fundamental Research

Reference DoD Directive 2040.2, "International Transfers of Technology, Goods, Services, and Munitions."

This memorandum defines "fundamental research" in the context of the Administration's recent draft national policy on the transfer of scientific and technical information (attachment 1). The statement requires that, consistent with existing statutes, no controls other than classification may be imposed on fundamental research and its results when performed under a federally supported contract. I would like the policy to be applied consistently to all DoD sponsored research. The policy, however, does not and cannot remove the necessity for sound judgment by all concerned.

Experience shows that attempts to define the terms "basic", "applied", or "fundamental" by elaborating the concept do not necessarily sharpen distinctions for decision making. Simple , unambiguous characteristics, though not perfect, are more useful discriminants. For DoD purposes the decision whether a particular research activity is or is not fundamental will be determined primarily by considering the following easily identified characteristics: (1) performer (for example, university, industry, in-house), (2) budget category (for example, 6.1, 6.2), (3) sponsoring DoD entity, (4) special contractual provisions.

The new policy addresses contracted research, which in the context of DoD is extended to include grants. Unclassified contract research supported by 6.1 funding shall be considered "fundamental." Similarly, unclassified research performed on campus at a university and supported by 6.2 funding shall with rare exceptions be considered "fundamental;" where there is a high

likelihood of disclosing performance characteristics of military systems, or of manufacturing technologies unique and critical to defense, more restrictive con' ıctual clauses may be agreed to by the contracting parties prior ıo effecting the contract. Contract research performed in off-campus university facilities that is not 6.1 funded generally will not be considered "fundamental."

Furthermore, in order to ensure reasonably consistent treatment for the publication of the results of fundamental research performed in DoD laboratories and components, the guidance provided in Attachment 2 will be followed closely.

In no case may further interpretation of this policy result in more restrictive conditions. In case of disagreements about the nature of research content or the applicability of any of the above policies, differences should be resolved by the Service or Agency providing funding support, and if this fails to result in a resolution, individual cases or questions may be referred to Subpanel B -"Research and Development", as provided for in the referenced directive.

Attachments

NATIONAL POLICY ON THE TRANSFER OF SCIENTIFIC AND TECHNICAL INFORMATION

(Draft of June 15, 1984)

I. PURPOSE

This directive establishes national policy for controlling the flow of science and technology information produced in fundamental research at colleges, universities, and laboratories under contract to U.S. government agencies.

II. BACKGROUND

The acquisition of advanced technology from the United States by Eastern Bloc nations for the purpose of enhancing their military capabilities poses a significant threat to our national security. Intelligence studies indicate a small but significant target of the Eastern Bloc intelligence gathering effort is science and engineering research performed at universities and federal laboratories. At the same time, our leadership position in science and technology is an essential element in our economic and physical security. The strength of American science requires a research environment conducive to creativity, an environment in which the free exchange of ideas is a vital component.

In 1982, the Department of Defense and National Science Foundation sponsored a National Academy of Sciences study of the need for controls on scientific information. This study was chaired by Dr. Dale Corson, President Emeritus of Cornell University. It concluded that, while there has been a significant transfer of U.S. technology to the Soviet Union, the transfer has occurred through many routes with universities and open scientific communication of fundamental research being a minor contributor. Yet as the emerging government-university-industry partnership in research activities continues to grow, a more significant problem may well develop.

III. POLICY STATEMENT

It is the policy of this administration that the mechanism for control of fundamental research in science and engineering at colleges, universities and laboratories under contract to U.S. Government Agencies is classification. Consistency of this policy with applicable U.S. Statutes must be maintained. Each federal government agency is responsible for: a) determining whether classification is appropriate prior to the award of a research grant or contract and, if so, controlling the research results through standard classification procedures; b) periodically reviewing all research grants or contracts for potential classification. No restrictions may be placed upon the conduct or reporting of fundamental research that has not received national security classification.

ATTACHMENT 1

SCIENCE

Reprint Series
5 October 1984, volume 226, page 9

Scientific Communications and National Security

The conflicting imperatives of national security and open scientific communication have been the subject of a vigorous and sometimes emotional national debate. Differing priorities have led to incompatible conclusions. In times of peace and security, the maximum freedom of speech and communication has served this nation well; in times of great peril, national security considerations have temporarily displaced those precious freedoms. In this period of world history when nations in competition may win or lose by their technologies, both in combat and in commerce, how should we order our priorities regarding national security and scientific communications?

We must begin by recognizing the distinction between science and technology, between knowledge and know-how. Nature yields her secrets to anyone imaginative enough to ask the right questions, regardless of nationality. All participants benefit in the testing of new scientific hypotheses and the exchange of scientific information. Nor can the flow of ideas be stopped at national borders. On the other hand, know-how is a precious commodity leading to the commercial or military products that determine the fortunes of nations in peace and in war. Yet sometimes it is hard to tell where scientific knowledge leaves off and engineering know-how begins.

The potential for unintentional disclosure of national security information through the publication of basic research results is virtually nonexistent, and the benefits of such an open publications policy far outweigh the risks. The treatment of university R&D more applied in nature has been the subject of intensive discussions between university and Department of Defense representatives in the DOD-University Forum over the past 2 years. (The forum participants are drawn about equally from the academic and defense communities.) To put the matter in perspective, about 80 percent of R&D on university campuses sponsored by DOD falls in the category of basic research. The discussions have therefore focused on the other 20 percent, only a very small fraction of which has been of security concern.

The forum discussions have contributed greatly in formulating new policy that will provide for completely unrestricted publication (without delay) of all unclassified fundamental research carried out in any laboratory (university or industrial). Henceforth, consistent with U.S. statutes, the primary way to restrict the publication of contracted fundamental research will be to classify it. (The rules for classification are well understood. The DOD currently has no classified basic research on university campuses, and this situation is expected to continue. The government's power to classify is not new; it has not been and will not be invoked on university campuses except in the rarest of circumstances involving special reasons of national import, and with complete prior agreement of the university involved.)

The quickest way to disseminate research results is through meetings, conferences, and symposiums, often sponsored by scientific and engineering societies. Many meetings held in the United States are international, and it is important to keep them so. For government sponsored or cosponsored technical conferences, admission should likewise not depend on nationality but only on security considerations—it is in the best interests of all allied countries to share their technologies to lighten the burden of mutual defense. I also believe that no unclassified technical conference requiring an invitation should exclude individuals from allied nations who can contribute to the success of the conference.

The freedom to publish scientific and educational material is vital for progress in science and engineering. Ultimately the relationships among academia, government, and industry will depend on the trust and understanding among the people who work together and depend on one another.—RICHARD D. DELAUER, *Under Secretary of Defense for Research and Engineering, Department of Defense, Washington, D.C. 20301*

PART IV

DOD-UNIVERSITY FORUM WORKING GROUP

ON ENGINEERING AND SCIENCE EDUCATION

The nation's security has become increasingly dependent upon maintaining U.S. superiority in broad areas of science and technology. Our ability to sustain our leadership, however, will depend in large measure on the quality of the education available to the students of science and engineering who will make the technological advances of the future and on the opportunities advanced students will have to do research in defense related technologies.

Recognizing the needs of the Department of Defense for trained technical personnel and the current capabilities of the university community for producing an adequate supply of qualified engineers and scientists, the DoD-University Forum constituted a Working Group on Engineering and Science Education to assess the situation and recommend actions which should be taken to solve the problems identified by the Forum.

Dr. Robert C. Seamans, Jr., Henry R. Luce Professor of Environment and Public Policy at MIT, and Dr. Lawrence J. Korb, Assistant Secretary of Defense for Manpower, Installations and Logistics, were asked to co-chair the group. Membership was drawn about equally from the university community and from DoD.

The Forum asked the Working Group to:

- Review DoD needs for scientific and technical manpower, assess present DoD initiatives to strengthen the Department's engineering and science education activities, note potential deficiencies, and provide consultation and advice as appropriate.

- Examine the present "deteriorated" environment in university engineering and science departments, assess the effectiveness of present DoD efforts to resolve these issues, and identify key leverage points in universities and in DoD where action could be applied.

- Assess whether a support mechanism, modeled after the prepaid G.I. Bill used to attract medical doctors, could be developed appropriately to fill the Department's needs for Ph.D engineers and scientists; and examine the Department's continuing

education programs in the Services to assess whether DoD should increase opportunities for military and civilian personnel to pursue full-time advanced study in universities.

The following summarizes the Working Group's findings and recommendations:

SUMMARY OF FINDINGS:

A. DoD needs for scientific and technical manpower.

DoD has an important stake in the quality and supply of the national pool of engineers and scientists. Since DoD exerts a substantial influence over the entire system, it has a leadership responsibility to address the current crisis in engineering and science education.

- Of the 2.9 million scientists and engineers in the national workforce, 105,000 or 3.6 percent are employed by the Department of Defense in a civilian or military capacity. Of these 78,000 are civilians (72 percent of whom are engineers), and 27,000 are military officers.

- DoD also employs almost 740,000 technicians, 22,000 of whom are civilians. About 715,000 technically qualified individuals are in the military enlisted force and account for 40 percent of all enlisted personnel. Currently the Services are attracting sufficient numbers of qualified personnel for these positions, but the ability to recruit must be carefully monitored as military manpower requirements increase, the economy improves, and the enrollment of high school students drops.

- Beyond the 105,000 civilian and military engineers and scientists employed by the Department, another 13 percent of the nation's total S&E workforce is directly linked to Defense programs, budgets and policies.

- Forecasts undertaken by the National Science Foundation project potential shortages (5 percent to 10 percent) of electrical and electronic engineers employed by DoD contractors in 1987. Shortages greater than 10 percent in 1987 are predicted for aeronautical engineers, computer systems analysts and computer programmers.

- The shortages of both civilian and military S&E

personnel within the Defense Department are reasonably well documented, but the quality aspects of the problem are not as well defined or understood.

- Experienced, journeyman level (GS-12/13) civilian S&E personnel, who make up the bulk of civilian S&E's in DoD laboratories, are being lost in large numbers. These losses include a small but significant number of exceptionally well qualified personnel. The military has been experiencing a comparable loss with a drop in the number of mid-career S&E officers (O-3, O-4 and O-5) in the last 10 years.

- DoD has not taken full advantage of continuing education opportunities which legislative authorities have provided to send current, full-time civilian and military personnel to graduate programs.

- Although the occupation of computer professional is a readily recognized shortage area, government occupational classifications do not properly identify these skills. As a result, it is not possible to identify requirements, match the supply, or to allow rational hiring, assignment or career planning in these fields.

B. Assessment of DoD initiatives to meet internal S&E personnel needs.

The Department has undertaken a variety of initiatives to develop the technical personnel it will need in the future. These efforts, however, could be strengthened to maximize potential benefits.

- The Air Force bonus program for officers with critical S&E skills having between 4 and 12 years of service appears to be achieving desired retention results.

- ROTC scholarship programs are providing an increasing number of high-caliber new S&E officers having four-year service commitments.

- Civilian hires of new baccalaureate S&E personnel at GS-5/7 levels are currently in sufficient quantity. However, their quality does not appear to come up to the quality level of ROTC graduates.

- Cooperative education and work-related training programs for undergraduates (such as summer internships) have proven to be a most effective means to enhance recruitment and improve retention. Those involved in such programs have a high rate of conversion to full-time career employment in DoD, and they have been shown to have a good retention rate as well.

- The Defense Authorization Act of 1982 provided DoD laboratories with authority to contract with educational and non-profit institutions for the research services of students. This new authority, coupled with existing co-op education and other work experience programs, could become a highly effective recruitment tool for DoD R&D facilities.

C. Assessment of present "deteriorated" environment in university engineering and science departments and the related precollege foundation.

Research is fundamental to graduate education in engineering and science. Technological knowledge is not a static quantity but is rapidly advancing on many fronts. Engaging in research is an important educational experience. The products of research expand our knowledge and force changes in the engineering and science curricula.

The decline during the 1970's in government support for research at the nation's universities has resulted in a number of problems hampering both research and teaching.

- Deficiencies in research facilities and equipment are acute in most universities. Research instrumentation has grown sophisticated and research costs have risen sharply while there has been a severe and prolonged erosion in the condition of many university laboratories. As a result, quality research efforts have shifted to a limited number of superior laboratories which have sources of funding enabling them to keep up.

- During the 70's the salaries of Ph.D.'s on university faculties did not keep up with salaries offered to S&E bachelors by private industry. Consequently, the supply of new Ph.D.'s in engineering has dropped considerably in recent years.

- Another consequence of this pay differential has been a luring away of high-caliber graduate

students and young faculty out of the universities into challenging, well-paid positions with industry. This has generated a shortage of quality engineering faculty in many universities together with unusually heavy teaching loads. This situation, in turn, has further lessened the attractiveness of a university teaching career for Ph.D.'s interested in research.

- The precollege foundation which supports S&E education in the universities has eroded as the number of high school students enrolling in math and science courses has dropped and the quality of education they have been receiving at this level has declined.

- Serious shortages now exist in the number of qualified math and science teachers at the high school level, and there has been a general decline in the quality of those who are teaching at this level.

- The deterioration of university research and education has been addressed by both the Senate and House Armed Services Committees, whose members have supported recent DoD initiatives in these areas.

D. Assessment of DoD remedial actions currently underway to strengthen engineering and science education.

DoD funding for basic research has been increased in recent years. The present policy of providing 7 percent real growth will have to be sustained for at least 5 years if university resarch capabilities are to be fully restored to the level they were in 1965.

- Current budget proposals have been made to allow increases for Defense research. (If Congress cuts requests for these funds, as it has done in 16 of the last 20 years, there will be a continuing decline in real DoD investment in university research.)

- The Army, Navy and Air Force have begun graduate fellowship and specialized assistantship programs in support of Defense related disciplines.

- In FY 83 DoD initiated a University Research Instrumentation Program. Jointly managed by the Services' research offices, the program is planned for five years at $30 million per year. To

establish the program DoD requested an increase in FY 83 Congressional appropriations for the 6.1 research budget of $132 million (or 14 percent in real growth) over FY 82 funding. Of this amount, $30 million was set aside for the instrumentation program. Final Congressional appropriations, however, reduced the real growth increase in the 6.1 research budget from the requested 14 percent to 6.7 percent, of which 4.3 percent remained earmarked for the instrumentation program. With 4.3 percent, or almost two-thirds of the increase, earmarked for the instrumentation program, the net real growth in the FY 83 research budget was only 2.4 percent over FY 82.

- DoD has initiated a new Independent Research and Development (IR&D) policy supported through allowed overhead on DoD and NASA contracts, and designed to enable industrial contractors to support university research.

- There is a limited Summer Faculty Program in operation at DoD laboratories which provides summer research opportunities to university faculty members.

SUMMARY OF RECOMMENDATIONS:

Based on the foregoing findings the Working Group on Engineering and Science Education makes the following recommendations to the DoD-University Forum:

1. Policies of support for university research should be continued. Any new initiatives should be funded with new appropriations so as not to threaten real growth in the research budget.

2. A study should be made of current qualitative aspects in the DoD S&E workforce. The dimensions of the qualitative problem are relatively unknown and need to be defined and assessed.

3. A focal point for S&E education should be established in OSD. An office should be charged with primary responsibility for developing and coordinating education and training policy Department-wide in all S&E-related areas.

4. Military undergraduate and graduate level S&E education and bonus programs should be continued and strengthened, including ROTC and graduate officer programs at the Air Force Institute of Technology, the Naval Post

Graduate School, and civilian colleges and universities. Army and Navy should examine Air Force experience with bonus programs with a view toward considering implementing appropriate initiatives in their own Services.

5. Civilian precollege undergraduate and graduate level assistance programs should be continued and strengthened. DoD should:

a. Utilize more fully precollege and undergraduate work-experience programs to provide a series of work and learning experiences for young people in DoD research facilities.

b. Increase utilization of financial support authorities now possible with the cooperative education program in order to meet the perceived need for educational assistance for undergraduate S&E students.

c. Establish a new graduate education program for civilians, not limited to current employees, to provide scholarships for experienced S&E personnel to obtain advanced S&E degrees in order to replace those experienced employees at mid-grade that are now being lost to industry and academia. A commensurate service commitment should be required.

d. Request Office of Personnel Management to identify a separate occupational skill code for civilians qualified and working as computer engineers; request higher pay scales for computer scientists similar to those for engineers to enable government to compete with the private sector for these scarce skills.

6. Opportunities for continuing education for civilian S&E's now employed by DoD should be increased. Administrative and legal limitations must be addressed in order to enhance utilization of currently available continuing education opportunities.

7. Interchanges between senior government S&E personnel and their colleagues in industry and academia should be increased.

8. A comprehensive Faculty Development Program should be established. It is recommended that DoD formulate policies and programs to foster faculty development and to stimulate interest among younger faculty in research careers in areas important to the Department.

9. DoD graduate fellowship programs should be strengthened. Present programs emphasize quality but are very small. Programs should be increased without altering the emphasis on quality.

10. Development of university programs in Defense related technologies should be encouraged. A standing committee of DoD and university representatives should be established to encourage the development of university programs in response to specific Defense needs.

11. The DoD-University Research Instrumentation Program should be strengthened. It is recommended that this program be expanded with new appropriations to a level of $100 million per year and that it be sustained at that level for at least another 5 years.

12. A University Research Facilities Rehabilitation Program should be established. DoD should undertake a research laboratory rehabilitation program targeted on fields of interest to Defense, and encourage other agencies to begin similar programs each in furtherance of their particular interests and missions.

NOTE: In addition to the members of the Engineering and Science Education Working Group whose names are published in Appendix B, Dr. Richard D. Zdanis, Vice Provost of The Johns Hopkins University and Dr. Joseph F. Traub, Chairman of the Computer Science Department at Columbia University also contributed to this Report of the Engineering and Science Education Working Group of the DoD-University Forum.

PART V

DOD-UNIVERSITY FORUM WORKING GROUP

ON FOREIGN LANGUAGES AND AREA STUDIES

One of the areas identified by the DSB Task Force on University Responsiveness as requiring attention was foreign languages and area studies. In their report, they recommended that:

> The Secretary of Defense encourage other agencies to strengthen existing foreign language and area study programs, particularly those authorized under Title VI of the Higher Education Act of 1980. In addition, the Department should assess the consequences for our national security of the weakened university research and training capabilities in these areas, and expand the use of appropriate DoD mechanisms to support work of particular significance to defense needs.

The Working Group on Foreign Languages and Area Studies was established under the DoD-University Forum and asked to:

- Assess the consequences for national security of the present weakened condition of university research and training capabilities in foreign languages and area studies.

- Review current DoD approaches to this problem in light of the needs, interests and constraints of the academic community and propose for discussion appropriate alternative mechanisms for direct and indirect DoD support for work of particular significance to defense needs.

- Review existing language and area studies programs of other agencies, particularly those authorized under Title VI of the Higher Education Act of 1980, and propose ways for DoD to show its support for them.

A Working Group under the co-chairmanship of Dr. Irving Shain, Chancellor of the Unversity of Wisconsin, and Mr. Robert Prestel, Assistant Director for Training, National Security Agency/Central Security Service, was established and composed equally of DoD and university officials with expertise in the subject area. Later, LTG William E. Odom, Assistant Chief of Staff for Intelligence, Department of the

Army, assumed the role of DoD co-chair when a change in job assignments made it necessary for Mr. Prestel to spend less time on Working Group activity.

As the Working Group was being formed, the House and Senate Conferees on the Department of Defense Authorization Act of 1983 concurrently requested DoD to undertake an assessment of the nation's research and education capabilities in foreign languages and area studies (H. Report 97-749, page 123). As a result of this request, it was decided that it would be logical to dovetail the efforts of the Working Group with the required assessment. The Department of Defense then asked the Association of American Universities, under contract with the Department of the Army acting on behalf of DoD, to conduct the assessment and report its findings and recommendations to the Department and to the Working Group on Foreign Languages and Area Studies of the DoD-University Forum. Supplemental assistance was provided by the National Endowment for the Humanities and enabled AAU to broaden the scope of the project to include consideration of the humanities. Selected members of the Working Group participated on a steering committee established to oversee the progress of the contract, and status reports were made periodically to the full Working Group and the Forum.

The resulting study, titled, "Beyond Growth: The Next Stage in Language and Area Studies," is summarized below:

OBJECTIVES OF THE STUDY:

- Assess on a comprehensive basis the condition of the nation's research and advanced education resource base in language and area studies.

- Identify the components of language and area studies that are in greatest jeopardy in the current financial and institutional climate on American campuses.

- Identify which aspects of language and area studies need to be strengthened and/or changed to serve maximally the national needs.

- Determine the need for and appropriate role of various government agencies in support of language and area studies.

METHODOLOGY

- Twenty public and private universities were visited to review a wide range of language and area studies programs. On each campus, programs of very different size and degree of organization were examined; over 50 percent of all area centers supported by Title VI were covered. In all, the site visit team met with about 35 top university administrators; more than 50 center directors; 300 faculty members; and 150 students. The team also met with library administrators and area bibliographers and with chairmen of appropriate departments.

- University applications for Title VI support were analyzed to determine the research profile of publications on language and area studies and to assess changes over time in the disciplinary spread of faculty and courses at centers. Over 7,000 publications of faculty at 72 of the 76 centers supported by Title VI were coded for country, disciplinary, and topical coverage; information on changes between 1976-82 in the enrollments and disciplinary spread of courses and faculty at 39 Title VI centers were also tabulated.

- The training patterns of 344 specialist trainee applicants for Title VI dissertation year Fulbright fellowships were analyzed to determine how many courses in language and area studies a student who is training to become an area specialist actually takes during his graduate career.

- Unpublished data were secured from a variety of sources on the following topics: language enrollments in the U.S.; data on the training and career patterns of both FLAS fellowship recipients and, in particular, of Soviet and East European specialists; grants awarded under the Fulbright program; funding patterns by a variety of government agencies and by foundations of research on language and area studies. A separate report, prepared by SRI International under a subcontract with AAU, analyzed DoD needs for language and area studies expertise.

THE PROBLEM:

The past several decades of combined Federal and private support, plus the resources invested by universities and individual scholars and students, have created an immensely valuable national resource in language and area studies that is unrivaled anywhere in the world. However, the period of rapid growth and expansion has come to an end. There are clear signs that important parts of this national resource are in danger of serious decline. Furthermore, the period of largely undirected growth has left vital gaps in both the research and teaching components of language and area studies programs. These gaps result from the preferences of scholars within specific disciplines and from the narrowly focused missions of the various government research funding agencies.

The funding mechanisms for language and area studies campus programs as well as for the national organizations that help support research on the various world areas are too inflexible, inadequate, lacking in monitoring capacities, and precarious to meet the nation's needs.

ASSESSMENT AND MAJOR RECOMMENDATIONS:

All recommendations are made with reference to the particular government agencies and private organizations most interested in their implementation.

LANGUAGE COMPETENCY

- There is currently no objective way of measuring a person's language proficiency. A national performance-oriented metric is urgently needed.

- Language proficiency tends to be low for too many specialists and trainees. Programs should place more emphasis on the acquisition and retention of higher levels of language skills.

- The least commonly taught languages are the most vulnerable component of language and area campus programs. Owing to low enrollments and the pressures of fiscal constraints in universities, the danger exists that the capacity to teach the least commonly taught languages will be lost on all campuses simultaneously.

RECOMMENDATIONS:

- Make it possible for the campus and government language teaching systems to be more interactive and mutually supportive.

- Fund pedogogical research on such topics as the development of a uniform proficiency metric; language attrition; effective styles of language instruction; use of computers in language instruction.

- Assist in the expansion of year-long and summer intensive language instruction facilities and in resources for individualized, self-paced instruction to meet dispersed needs.

- Partially endow positions on campuses and specially earmark a portion of Title VI monies for the endangered languages to preserve the teaching capacity in the least commonly taught of these languages.

- Establish pedagogical institutes as catalysts to conduct the research mentioned above, to introduce the changes recommended and to train the staff necessary for the transformation of language teaching in America.

AREA COMPETENCY:

- The area component of a graduate student's training is less than optimal. Though there are important differences among the disciplinary departments, the overwhelming majority of a student's training tends to be within his major, and in too many cases too little of it is directly concerned with the area.

- The financial aid available for graduate training in language and area studies does not reflect the long taining period necessary to become an area specialist--the time it takes to learn a foreign language and to do research overseas.

- There is a growing disciplinary imbalance; few social scientists with area expertise are being trained and those already in the field are either turning to more domestic interests or not being replaced as they retire.

RECOMMENDATIONS:

- A program of two-tiered fellowships to train specialists should be introduced. The first tier should be allocated directly to university language and area centers to cover the first two years of training of students, as is currently the case. The second tier should be portable, merit-based

fellowships awarded directly to students in a national competition. To win this national fellowship for advanced work, a student should have to demonstrate a high level of both language and area competency. These advanced fellowships ought to be of four year's duration and portable both domestically and abroad.

- To guarantee replacement of scarce-skill specialists, a small number of fellowships should be allocated to students wishing to train with eminent scholars who have a rare combination of diciplinary and area skills. A small number of such fellowships of at least four years' duration should be awarded to a highly promising set of students to enable them to study with a prominent social scientist.

RESEARCH:

- The cumulative effect of policy decisions in Federal support for language and area studies research and the laissez-faire selection of research topics have resulted in important gaps in the geographical and disciplinary coverage of the research product of language and area specialists. In addition, research directly relevant to public and business policy decisions has been relatively scarce.

- The terms of research access worldwide are becoming harder to negotiate for a variety of reasons, putting limits on the sources of support that can effectively be used to conduct overseas research in most of the developing world.

- There is little large-scale, multi-year, interdisciplinary research being conducted in the field. Research support that is available is almost entirely for individual fellowships and for short overseas sojourns.

- There is currently no planned, durable, and sufficient source of support for the essential national organizations that now facilitate both domestic and overseas research on the area.

RECOMMENDATIONS:

- Establish an ongoing monitoring mechanism to identify gaps in research.

- Provide money, in part through the various mission-oriented Federal agencies, to create center "segments," that is, units of five or six scholars and their students that can (1) fill gaps in the national component of language and area expertise; (2) provide continuing centers for sustained research and teaching on topics of special interest to public or private policy formulation; and (3) provide special mechanisms for mission-oriented agencies to relate to the various area studies fields in a more sustained fashion.

- Develop a long-term funding mechanism for the organizations that monitor and fund research on the field.

- Provide money for medium and larger-scale research.

- Create additional opportunities for scholars to meet and exchange ideas in an environment like that of the Wilson Center of the Smithsonian Institute.

LIBRARY AND INFORMATION RESOURCES:

- Foreign language and area materials raise special problems in acquisitions, cataloguing, preservation, computerization, and training of staff. There is a pressing need for long-term funding and for resource sharing and planning.

- Too little has been done to articulate the campus-based library and information storage systems with those in the various Federal agencies.

RECOMMENDATIONS:

The following surveys should be conducted:

- A review of the current status of mutual support between academic and government library and information storage systems.

- A review from the perspective of university administrators and general librarians, and area specialist librarians and faculty, of the special problems with the area-related collections.

- A survey of the patterns of use of area library collections.

CONCLUSION:

Taking into consideration the different stages of development of the various world area study groups, the field as a whole must recognize that it has for the most part completed the first stage of its development--laissez faire growth--and should now direct its attention to the next stage of language and area studies. It is essential, however, that existing patterns of support, particularly the general support for campus-based centers now provided through Title VI, should be continued. The advances already made in the creation of this vital national resource must not be allowed to slip away. In these precarious financial times for universities, these resources, once gone, are unlikely to be rebuilt.

In this new phase, however, efforts should be made to monitor the cross-sectional nature of the field in order to allocate resources in a way that will better meet the nation's needs for language and area expertise. The report's recommendations for new programs or modifications of existing programs call for relatively small but carefully targeted investments. They present a low-cost, high-leverage strategy of investment that will both secure the existing national resources built up at such great expense and effort, and enable them to reach more fully the national interest goals originally set for them: to train high-quality students to an advanced level of language and area competency, and to produce a systematic body of knowledge on other countries to inform our educational system, the public, and the makers of our national policy.

To carry out the difficult task of adapting existing campus resources to meet the demands of the next stage of language and area studies and to help mediate between Federal and campus-based activities in the national interest, the feasibility of establishing an integrated funding mechanism for international studies should be explored immediately. Part of the support for such a foundation might come from the sale of American assets or loan repayments from abroad.

With or without a separate funding mechanism, if a more directive strategy is to be successful, a major upgrading in the capacity to monitor, plan and evaluate, from the perspective of the national interest, and dispersed activities on the campuses and within the Federal Government and in the field of language and area studies is essential.

FUTURE STUDIES:

The following studies are recommended:

- A complete exploration, including a detailed feasibility study, of the need for a new national funding organization dedicated to the support and integrated planning of language and area studies;

- A survey of the national organizations that serve various collective needs of one or another aspect of the field, but which are not included in any durable funding program, that addresses the needs of language and area studies. This survey should determine where there are areas of redundancy and gaps in the needs of the field at the national level.

- A review of the obstacles to research access in other countries, with a view to establishing bilateral mutual agreements to counter the deteriorating situation.

PART VI

CONCLUSION

As the first full year of the Forum closes, it is probably fair to say that the principal concern of the Forum now is the part DoD must play in supporting science and engineering education to enhance the success of its mission which is national security. Dr. DeLauer's letter to the President and to government, industry and unversity leaders has elicited a strong and favorable response, particularly from the Office of Science and Technology Policy, and has resulted in a joint DoD-OSTP initiative. This initiative would increase Basic Research (6.1) funding to support people, institutions, and interactions which serve to provide quality education and training in defense related research, as well as the more effective transitioning of people, ideas, and new technologies from academic training grounds into defense related research. That research, being at the cutting edge of technology, has a proven record of spinning off commercial products and manufacturing technologies which benefit the country not only in combat but also in commerce.

With the advice of the Forum, the assistance of OSTP, and the support of knowledgeable people, we look forward to the future with confidence.

APPENDIX A

CHARTER
DOD-UNIVERSITY FORUM

A. Official Designation: The Advisory Committee shall be known as the DoD-University Forum. The Forum shall be co-sponsored by the Department of Defense, the Association of American Universities, the American Council on Education and the National Association of State Universities and Land Grant Colleges.

B. Objectives and Scope of Activities: The Forum shall advise the Department of Defense on a wide range of issues affecting the nation's university research and education programs vital to national defense, and shall be constituted to allow periodic consultations between senior university representatives and DoD officials on the full range of research-related needs and issues that affect the Department's ties with universities. In accomplishing its mission, the Forum may establish subsidiary working groups or subcommittees as necessary to perform indepth examinations of relevant topics, and report their findings and recommendations to aid in the Forum's deliberations. Working group/subcommittee members will be appointed as associate members of the Forum.

The Forum shall be composed of approximately twelve (12) civilian members who are authorities in their field and respected members of the academic community. University members will be nominated by the education associations named above and appointed by the Under Secretary of Defense for Research and Engineering who serves as the DoD Co-Chairman of the Forum. A university member will be elected by the university membership to serve as the University Co-Chairman. Members are subject to approval by the Secretary of Defense, and shall serve as individuals and not as official representatives of any group or organization with which they are affiliated. An equal number of officials representing the Office of the Secretary of Defense and the Military Departments will also be appointed to Forum membership. The same procedures will be followed in appointing associate members to the Forum, and in establishing the leadership of Forum working groups and sub-committees. Term of membership is two years; members may be reappointed for two more consecutive terms.

C. Period of Time Necessary for the Committee to Carry Out Its Purpose: Indefinite.

D. Official to Whom the Committee Reports: The Forum reports to the Under Secretary of Defense for Research and Engineering, who serves as the DoD Co-Chairman. The Forum shall meet at the invitation of both the DoD and University Co-Chairmen. The Under Secretary of Defense for Research and Engineering shall designate a Federal Government officer or employee to attend each meeting and serve as Executive Secretary of the Forum. In the absence of the Under Secretary of Defense, the officer or employee so designated as Executive Secretary shall have the authority to adjourn any meeting of the Forum which is not considered to be in the public interest.

E. Agency Responsible for Providing the Necessary Support: The Office of the Under Secretary of Defense for Research and Engineering, together with the association co-sponsors, will provide such personnel, facilities, and other administrative support as deemed necessary for the performance of the Forum's functions. Information and assistance to support Forum deliberations may be required from other offices within the Office of the Secretary of Defense, the Military Departments and the Defense Agencies.

F. Duties: The mission of the DoD-University Forum is to assist and advise the Deparment of Defense on university research and related education issues important to the national defense.

G. Annual Operating Costs and Workyears: It is estimated that the annual operating costs for the Forum, including its subcommittees, will not exceed $200,000.

H. Number and Frequency of Forum Meetings: A minimum of two (2) formal meetings shall be held annually, and the presence of a majority of the members shall constitute a quorum. Working groups or subcommittees created by the Forum to undertake indepth examinations of various issues related to the Forum's mission, shall also meet a minimum of two (2) times annually. The presence of the majority of the members of the subcommittee or working group shall also constitute a quorum.

I. Termination Date: The Forum shall terminate upon the completion of its mission, as determined by the Under Secretary of Defense for Research and Engineering, or two years from the date this Charter is filed with Congress.

J. Compliance: The Forum shall comply with all the requirements of P.L. 92-463, DoDD 5105.18 and other applicable directives and regulations.

K. Filing Date: This Committee Charter was filed, as required on December 15, 1983.

APPENDIX B

October 1984

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